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Nuts and Bolts of Computing the Ephemeris

Part 3

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INTRODUCTION

We have discussed some of the inputs necessary for calculating the Ephemeris such as, the date and time systems. Some of part one and two were sideline information that you may need to dress up the Ephemeris. Before getting started on the primary equations for the Ephemeris let's discuss some pesky transform routines. To correct a previous problem with the year 2000 leap day, a new routine for Julian date is discussed.

PROGRAMMING TIPS

We may wish to start with come essential constants in the General section of our Visual Basic form with:

```
Const PI = 3.14159265

Const rad = PI / 180
```

"rad" is necessary in Basic to convert trigonometric calculations from radians to degrees and the reverse. Here are a couple function-calls for inverse sine and cosine:

```
Function Arcsin(X)

X = Atn(X / Sqr(-X * X + 1)) / rad

End Function

Function Arccos(X)

X = (Atn(-X / Sqr(-X * X + 1)) + 2 * Atn(1)) / rad

End Function
```

Many of the long equations result in angles of five digit angles, meaningless for real world thinking. A good sub-routine can written into our program as a Function Call. Some of the results of the equations will return angles over 360 degrees. At times it is necessary to "normalize" the results to a value at or below 360 degrees. A handy call is:

Function NORMALIZE(X)

X = ((X / 360) - Int(X / 360)) * 360

End Function

Some trigonometric functions may result in erroneous angles that will throw the positions of a planet way out of bounds. First, when any equation contains the tangent (TAN) it is possible to end up in the wrong quadrant of the circle. Once your author printed a daily listing of the Ephemeris of Mars and was surprised to find the right ascension changed from 23:59:59 to 12:00:00! A simple over sight caused this. So, when a TAN shows up, as in the following equation:

X = Tan B / Cos LA

The result may be in the wrong sign and quadrant. So it may be necessary to find the inverse tangent of the denominator and numerator, as in this equation, and the signs of each. Also, it may be a good time to convert from radial measure to degrees. If the denominator is negative then we add 180 to the result and find the correct quadrant. Also, this is a good one for the Function Call routine. FORTRAN incorporates a nice callATN2 that accomplishes this for you. Basic does not! So let's just emulate FORTRAN with a Function Call.

An example for equation X = Tan B / Cos LA, simply tag the numerator and dominator as, RX = Tan B: RY = Cos LA, then:

Call Function Arctan2(RX, RY, X)

Function Arctan2(RX,RY,Y)

X= Atn(RX / RY) / rad

If RY < 0 Then X = X + 180

End Function

This is a little rough, but you get the idea. Remember, this routine works. There are other neat sub-routines and function calls that will be discussed as we develop the Ephemeris. Part Four. We will then begin with the main routine to calculate the Ephemeris of Mars. Later we will replace sections of the Mars code to produce an Ephemeris for Jupiter and Saturn.

Because the Solar System doesn't conform to our time measuring systems, a brief note on Delta Time (Δ t) is in order. Delta Time the difference between Universal Time and the time of our Solar System as determined by the U.S. Naval Observatory and is not readily available until they compute it each year. Here is an approximation of the value in equation form:

```
Sub DeltaT()

        If UnivYear > 1997 Then DT = -183.5343 - 0.1472927 * UnivYear - 0.00003856419 *
        UnivYear ^ 2

        + 0.00000008706996 * UnivYear ^ 3

End Sub
```

CORRECTION: In *Nuts and Bolts of Computing the Ephemeris - Part One* a routine for calculating the Julian Date gave a method that resulted in an erroneous Julian date from March 1, 2000 throughout the remaining year. The following routine will correct the discrepancy:

Many astronomical applications use the Julian date system in calculations, so let's begin each with how to find the Julian Day number and several fractional parts of the Julian Century:

```
If UnivMonth <= 2 Then

Y1 = UnivYear - 1

UnivMonth1 = UnivMonth + 12

Else

Y1 = UnivYear

UnivMonth1 = UnivMonth

End If

JulianDate = Int(365.25 * (Y1 + 4716)) + Int(30.6001 * (UnivMonth1 + 1)) + UnivDay

+ (2 - Int(Y1 / 100) + Int(Int(Y1 / 100) / 4)) - 1524.5
```

The Julian date can be further adjusted to include the time of day by dividing the Universal time by 24 and adding it to the Julian date:

```
txtJulian.Text = Format(JulianDate + UnivTime / 24, "#########.###")
```

Many of the equations in our Ephemeris calculations require the fractional parts of the Julian Century:

```
T = (JulianDate - 2415020) / 36525
```

T2 = T * T

T3 = T * T * T

In Part 4 we will look at the nuts & bolts code for calculating a daily listing of the Ephemeris of Mars. The complete Microsoft Visual Basic source file will be posted in the resources section of the Computing Section web page.

Click Here to Go Back to The Digital Lens